10 can be included which is contacted by the user when the user operates the touchpad 16 and which can provide haptic feedback. Having a moveable portion of a housing for haptic feedback is described in U.S. Pat. Nos. 6,184,868 and 6,088,019, both incorporated herein by reference. In some embodiments, both the housing can provide haptic feedback (e.g., through the use of an eccentric rotating mass on a motor coupled to the housing) and the touchpad 16 can provide separate haptic feedback. This can allow the host to control two different tactile sensations simultaneously to the user; for example, a vibration of a low frequency can be conveyed through the housing to the user and a higher frequency vibration can be conveyed to the user through the touchpad 16. Each other button or other control provided with haptic feedback can also provide tactile feedback independently from the other controls.

[0048] The host application program(s) and/or operating system preferably displays graphical images of the environment on display device 12. The software and environment running on the host computer 12 may be of a wide variety. For example, the host application program can be a word processor, spreadsheet, movie, video or computer game, drawing program, operating system, graphical user interface, simulation, Web page or browser that implements HTML or VRML instructions, scientific analysis program, virtual reality training program or application, or other application program that utilizes input from the touchpad 16 and outputs force feedback commands to the touchpad 16. For example, many games and other application programs include force feedback functionality and may communicate with the touchpad 16 using a standard protocol/drivers such as 1-Force®, FEELit®, or Touchsense™ available from Immersion Corporation of San Jose, Calif.

[0049] The touchpad 16 can include circuitry necessary to report control signals to the microprocessor of the host computer 10 and to process command signals from the host's microprocessor. For example, appropriate sensors (and related circuitry) are used to report the position of the user's finger on the touchpad 16. The touchpad device also includes circuitry that receives signals from the host and outputs tactile sensations in accordance with the host signals using one or more actuators. Some touchpads may be integrated with a printed circuit board (PCB) that includes some of these components and circuitry. In some embodiments, a separate, local microprocessor can be provided for the touchpad 16 to both report touchpad sensor data to the host and/or to carry out force commands received from the host, such commands including, for example, the type of haptic sensation and parameters describing the commanded haptic sensation. Alternatively, the touchpad microprocessor can simply pass streamed data from the main processor to the actuators. The term "force information" can include both commands/parameters and/or streamed data. The touchpad microprocessor can implement haptic sensations independently after receiving a host command by controlling the touchpad actuators; or, the host processor can maintain a greater degree of control over the haptic sensations by controlling the actuators more directly. In other embodiments, logic circuitry such as state machines provided for the touchpad 16 can handle haptic sensations as directed by the host main processor. Architectures and control methods that can be used for reading sensor signals and providing haptic feedback for a device are described in greater detail in U.S. Pat. No. 5,734,373 and copending application Nos.

09/669,029, 09/565,207, 09/376,649, and 09/687,744, all incorporated herein by reference in their entirety.

[0050] In existing touchpad embodiments, such as those manufactured by Synaptics Corp., particular characteristics and features are provided. The standard surface material for a touchpad is textured Mylar, and typically any non-conductive object can be used on the touchpad surface and be detected, though textured surfaces are better when a user's finger is used to point. The touchpad can also sense through thin overlays. There is typically space available for the additional of haptic feedback components; for example, on a 40×60 touchpad, over half of the board can be available for haptic circuitry.

[0051] Many touchpads include a "palm check" feature, which allows the laptop to sense whether the user is contacting the touchpad with a finger or with a palm or other part of the hand. Since the user may only be resting his or her palm and not be intending to provide input, the palm check feature would ignore input that is determined to be provided by a user's palm. Basically, the palm check feature computes the contact area made by the conductive object (finger, palm, arm, etc.). If the contact area exceeds a certain threshold, the contact is rejected. This feature can be turned off in many embodiments.

[0052] FIG. 2 is a perspective view of another embodiment of a device 30 which can include the active touchpad 16 of the present invention. The device can be a handheld remote control device 30, which the user grasps in one hand and manipulates controls to access the functions of an electronic device or appliance remotely by a user (such as a television, video cassette recorder or DVD player, audio/video receiver, Internet or network computer connected to a television, etc.). For example, several buttons 32 can be included on the remote control device 30 to manipulate functions of the controlled apparatus. A touchpad 16 can also be provided to allow the user to provide more sophisticated directional input. For example, a controlled apparatus may have a selection screen in which a cursor may be moved, and the touchpad 16 can be manipulated to control the cursor in two dimensions. The touchpad 16 includes the ability to output haptic sensations to the user as described herein, based on a controlled value or event. For example, a volume level passing a mid-point or reaching a maximum level can cause a pulse to be output to the touchpad and to the user.

[0053] In one application, the controlled apparatus can be a computer system such as Web-TV from Microsoft Corp. or other computing device which displays a graphical user interface and/or web pages accessed over a network such as the Internet. The user can control the direction of the cursor by moving a finger (or other object) on the touchpad 16. The cursor can be used to select and/or manipulate icons, windows, menu items, graphical buttons, slider bars, scroll bars, or other graphical objects in a graphical user interface or desktop interface. The cursor can also be used to select and/or manipulate graphical objects on a web page, such as links, images, buttons, etc. Other force sensations associated with graphical objects are described below with reference to FIG. 18.

[0054] FIG. 3 is a top plan view of another computer device embodiment 50 that can include any of the embodiments of haptic devices of the present invention. Device 50 is in the form of a portable computer device such as